Infant Abusive Head Trauma in A Military Cohort

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WHAT'S KNOWN ON THIS SUBJECT: Abusive head trauma (AHT) is a type of physical child abuse, with infants at the highest risk. Parental characteristics associated with AHT include stress, young age, and current military service. However, a comprehensive evaluation of AHT among military families is lacking.

WHAT THIS STUDY ADDS: Risk factors and rates of AHT among military families are similar to civilian populations when applying a similar definition. Infants born preterm or with birth defects may have a higher abuse risk.

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KEY WORDS

military personnel, shaken baby syndrome, child abuse, epidemiology

ABBREVIATIONS

AHT—abusive head trauma
CI—confidence interval
DoD—Department of Defense
FAP—Family Advocacy Program
ICD-9-CM—*International Classification of Diseases, Ninth Revision, Clinical Modification*
KID—Kids' Inpatient Database
OR—odds ratio

Ms Gumbs coordinated the study, drafted the initial manuscript, and reviewed and revised the manuscript; Drs Keenan, Runyan, Ryan, and Smith contributed to the design of the study and reviewed and revised the manuscript; Mr Sevick managed study data, performed analyses, and reviewed and revised the manuscript; Dr Conlin guided analyses and reviewed and revised the manuscript; Mr Lloyd was responsible for obtaining investigative data from the Department of Defense Family Advocacy Program and reviewed the final manuscript; and all authors approved the final manuscript as submitted.

(Continued on last page)

abstract

OBJECTIVE: Evaluate the rate of, and risk factors for, abusive head trauma (AHT) among infants born to military families and compare with civilian population rates.

METHODS: Electronic *International Classification of Diseases* data from the US Department of Defense (DoD) Birth and Infant Health Registry were used to identify infants born to military families from 1998 through 2005 (N = 676 827) who met the study definition for AHT. DoD Family Advocacy Program data were used to identify infants with substantiated reports of abuse. Rates within the military were compared with civilian population rates by applying an alternate AHT case definition used in a civilian study.

RESULTS: Applying the study definition, the estimated rate of substantiated military AHT was 34.0 cases in the first year of life per 100 000 live births. Using the alternate case definition, the estimated AHT rate was 25.6 cases per 100 000 live births. Infant risk factors for AHT included male sex, premature birth, and a diagnosed major birth defect. Parental risk factors included young maternal age (<21 years), lower sponsor rank or pay grade, and current maternal military service.

CONCLUSIONS: This is the first large database study of AHT with the ability to link investigative results to cases. Overall rates of AHT were consistent with civilian populations when using the same case definition codes. Infants most at risk, warranting special attention from military family support programs, include infants with parents in lower military pay grades, infants with military mothers, and infants born premature or with birth defects. *Pediatrics* 2013;132:668–676

Abusive head trauma (AHT) is a form of physical child abuse that occurs most frequently among infants. Victims of AHT may die, and sequelae among survivors may include poor cognitive and developmental outcomes.[1,2] AHT may be recognized acutely when infants require hospitalization or subacutely in an office setting when an infant's head circumference is noted to have increased abruptly. Population-level family risk factors for child abuse, including AHT, include parental stress, low social support, maternal depression, young parental age, and poverty.[3]

Children of US military families could be at special risk for AHT. Military families face unusual occupation-related stress from frequent geographical moves and absences due to training and combat deployments. These may decrease social support and are stressful for both the military member and the family.[4,5] However, military families have attributes and resources that likely protect against child abuse. These include the requirement for the service member to pass an aptitude test, ongoing employment, a high school education/equivalency or higher, and family support programs available to military members.[6] Previous studies of child abuse in military compared with civilian families have shown mixed results.[6–9] Generally, comparative studies have shown lower rates of neglect in the military population than in the civilian population and similar or higher rates of physical abuse.[10] Two studies that examined AHT in military populations reported an increased risk of AHT in the military compared with the civilian population.[11,12]

By using available military data sets, we examined the rate of substantiated, probable, and possible AHT in infants within the military population to examine risk factors for AHT and to determine if the rates of AHT in the military population are similar to those in the civilian population. Information gained from this study can be used to help the US Department of Defense (DoD) allocate resources for health and family services.

METHODS

Study Population

The study population included infants born to military families in the calendar years 1998 through 2005. Same-sex multiples were excluded from analyses because it is difficult to consistently differentiate their initial health care in the data set before each child's assignment of a unique medical identifier. This research was approved by the Naval Health Research Center institutional review board and conducted in compliance with all applicable federal regulations governing the protection of human subjects in research.

Data Sources

DoD Birth and Infant Health Registry

The DoD Birth and Infant Health Registry (Registry) captures comprehensive health care utilization data to identify live births and subsequent infant health encounters among infants born to military families whose care is insured by the DoD in both military and civilian medical facilities.[13] The Registry follows infants to 1 year of age or until the infant is no longer receiving DoD-sponsored care. Each inpatient and outpatient encounter is coded by *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) codes.[14] Infant data are linked to the military parent's (sponsor's) demographic data, including age, race/ethnicity, sex, educational level, service branch, rank, and marital status.

DoD Family Advocacy Program.

Each military service branch has a Family Advocacy Program (FAP) composed of a multidisciplinary team that responds to allegations of child abuse and neglect among military families.[15] The FAP assigns a designation of "substantiated," "unsubstantiated, unresolved," or "unsubstantiated, did not occur" to each case and stores this information in conjunction with the military parent's (sponsor's) Social Security number.

Case Ascertainment and Definitions

Cases were ascertained from the Registry by using ICD-9-CM codes (Table 1). Infants with at least 1 of the defined head injury codes in an inpatient encounter, or the code for shaken infant syndrome in an inpatient or outpatient record, met the study definition for head trauma. The codes chosen were based on the definition for traumatic brain injury developed by the Centers for Disease Control and Prevention[16] but excluded simple skull fractures and penetrating missile injuries. For the 800-series head injury codes, a fifth digit was not required, but any fifth digit present was accepted. Additionally, we recorded all ICD-9-CM codes for child maltreatment and eye injury, as well as external-cause-of-injury codes (E-codes), occurring at any point during an inpatient hospitalization (Table 1).

AHT categories were adapted from a draft Centers for Disease Control and Prevention operational definition for nonfatal AHT that is now formalized.[17] We categorized potential cases of AHT as substantiated, probable, or possible by using both ICD-9-CM code definitions and the investigative findings of the FAP (Table 2). FAP findings were linked to cases by the military sponsor's Social Security number to examine for temporal matches (ie, cases in which the FAP incident report date occurred 1 week before, or within 60 days of, a head trauma diagnosis). The FAP case determination was recorded for infants with a temporal FAP match.

TABLE 1 ICD-9-CM Codes Used to Define Potential Cases of Abusive Head Trauma Among Infants in the DoD Birth and Infant Health Registry, 1998–2005

Head Injury Codes	Description
800.1x–800.4x; 800.6x–800.9x	Fracture at vault of skull with mention of intracranial injury
801.1x–801.4x; 801.6x–801.9x	Fracture at base of skull with mention of intracranial injury
803.1x–803.4x; 803.6x–803.9x	Other skull fracture with mention of intracranial injury
804.1x–804.4x; 804.6x–804.9x	Multiple fractures of skull or face with mention of intracranial injury
850.0x–850.9x	Concussion
851.0x–851.9x	Cerebral laceration and contusion
852.0x–852.5x	Subarachnoid, subdural, and extradural hemorrhage following injury
853.0x–853.1x	Other and unspecified intracranial hemorrhage following injury
854.0x–854.1x	Intracranial injury of other and unspecified nature
Other head injury	
959.01	Unspecified head injury
Shaken infant syndrome	
995.55	Shaken infant syndrome specific code
Child maltreatment codes	
995.50	Child abuse unspecified
995.54	Child physical abuse
995.59	Other child abuse and neglect
Eye injury codes	
361.01, 361.02, 361.03, 361.04, 361.05	Recent retinal detachment
361.1, 361.3, 361.33, 361.8, 361.81, 362.81, 361.9	Retinal detachments and defects
362.4x	Separation of retinal layers
379.23	Vitreous hemorrhage
Cause-of-injury codes	
E960.0	Unarmed fight or brawl
E967.x	Perpetrator of abuse
E968.1, E968.2, E968.8, E968.9	Assault by other and unspecified means
E969	Late effect of inflicted injury

To be considered substantiated AHT, cases required both an ICD-9-CM code indicating head trauma and a temporal match with a substantiated FAP incident report (Table 2). Probable cases of AHT included infants with an ICD-9-CM code for shaken infant syndrome (995.55) from an inpatient hospitalization, but with no report of abuse in the FAP data, or hospitalized infants with a head injury code with a temporal match in the FAP database indicating a report of abuse that was "unsubstantiated, unresolved." Infants from the latter category were excluded from analyses if a code indicating birth injury (767.0x), motor vehicle crash (E800.0x–E829.x), medical misadventure (E870.0), or adverse effect of a specified surgical operation (E878.8) appeared during the head injury hospitalization. Possible cases of AHT included infants with no FAP report but who were hospitalized with a head injury code in conjunction with either a child maltreatment code or a cause code; those hospitalized with the unspecified head injury code (959.01), a child maltreatment code or cause code, and an eye injury code; or those hospitalized with a head injury code and an eye injury code. The same exclusions were applied as in the probable cases.

To determine if rates of AHT in the military population are consistent with civilian rates, we used an alternate method of case finding. We applied the definitions used by Ellingson et al[18] on the Kids' Inpatient Database (KID) to inpatient records in the Registry. Ellingson et al's definition uses a narrower range of ICD-9-CM codes/E-codes for defining AHT among infants (<1 year) in an inpatient population. The KID, an administrative data set, is part of the Healthcare Cost and Utilization Project from the Agency for Healthcare Research and Quality. The KID collects a randomly selected 80% sample of all non–birth-related pediatric discharges from all hospitals in the states that are surveyed in a given year.[19]

In an exploratory analysis of the effect of parental deployment in support of the current operations on the rate of AHT, deployment information was gathered on the military sponsor for all substantiated and probable cases of AHT and a comparison diagnosis of pneumonia among infants born on or after September 11, 2001. Pneumonia was chosen as a comparator because it provided a date relative to deployment for non-AHT cases, and it should not be a deployment-sensitive condition. An infant was considered deployment-exposed if his or her military parent had a deployment of ≥30 days' duration during 3 specified time frames: (1) deployed at the time of the event, (2) returned from deployment within 3 months before the event date, (3) returned from deployment >3 months before the event but not earlier than 3 months before the infant's date of birth. Alternatively, the infant was considered unexposed if the military parent was not deployed in any of the specified time frames. If an infant qualified for >1 deployment-exposure category, the specified order above was used as a priority of classification. Infant pneumonia was defined by the following ICD-9-CM codes: 480.xx, 481.xx, 482.xx, 483.xx, 484.xx, 485.xx, 486.xx, and 487.0x.

The comparison group for all analyses consisted of infants born in the same years who did not meet the AHT criteria for inclusion. Sponsor demographic information was obtained for all study infants, and deployment information was captured on sponsors with infants born on or after September 11, 2001.

TABLE 2 Criteria for Categorizing Victims of Abusive Head Trauma as Substantiated, Probable, or Possible Cases

Substantiated Case	Probable Case	Possible Case
Hospitalized + shaken infant syndrome specific code (995.55) + temporally substantiated abuse recorded in FAP[a]	Hospitalized + shaken infant syndrome specific code (995.55)	—
Hospitalized + head injury code + temporally substantiated abuse in FAP data[a]	Hospitalized + head injury code + unsubstantiated FAP match[b,c]	Hospitalized + head injury code + cause code and/or child-abuse-specific code
Outpatient encounter with shaken infant syndrome specific code (995.55) + temporally substantiated abuse in FAP data[a]	—	Hospitalized + head injury code + eye code[c]
Hospitalized + unspecified head injury code (959.01) + cause code and/or child-abuse-specific code + eye code + temporally substantiated abuse in FAP data[a]	—	Hospitalized + unspecified head injury code (959.01) + cause code and/or child-abuse-specific code + eye code
Hospitalized + late effect of inflicted injury code (E969) + head injury code + temporally substantiated abuse in FAP data[a]	—	—

[a] FAP report occurred 1 week before or within 60 days of diagnosis.

[b] Infants in this category have an FAP incident report dated 1 week before or within 60 days of diagnosis and are assigned situation "unsubstantiated, unresolved."

[c] Infants were excluded from analyses if listed codes appear in conjunction with a code indicating birth injury (767.0), motor vehicle crash (E800.x–E829.x), medical misadventure (E870.0), or adverse effect of a specified surgical operation (E878.8).

Statistical Analyses

The rates of substantiated, probable, and possible cases of AHT, with 95% confidence intervals (CIs), were calculated by using the total number of each type of case as the numerator and the number of live births in the cohort as the denominator.

Descriptive analyses examined each case type by military sponsor parent, maternal, and infant demographic characteristics (Table 3). Infant demographic characteristics included sex, prematurity (≤36 weeks' gestational age), and presence or absence of ICD-9-CM codes indicating a major birth defect, as defined by the National Birth Defects Prevention Network[20] and captured in the Registry. Cases of atrial septal defect (745.5x) and patent ductus arteriosus (747.0x) in preterm infants were not included as birth defects in accordance with Metropolitan Atlanta Congenital Defects Program guidelines.[21]

Odds ratios (ORs) were calculated by logistic regression modeling on the combined group of substantiated and probable cases to reduce the risk of misclassification. A multivariable logistic regression model adjusted for infant sex, birth defect status, and birth term status; maternal age and military/marital status; and sponsor service branch, rank, race/ethnicity, education, and duty status was developed to assess adjusted ORs and 95% CIs. We omitted sponsor age from the multivariable model because of collinearity with maternal age and maternal military/marital status.

Data management and statistical analyses were performed by using SAS software, version 9.2 (SAS Institute, Cary, NC).

RESULTS

There were 676 827 infants who met inclusion criteria. Among these infants, 230 had substantiated AHT, 35 had probable AHT, and 38 had possible AHT. Seventy-three (0.01%) infants were removed from further analysis secondary to unspecified sponsor rank. Infant and sponsor characteristics for each AHT category and the entire Registry are shown in Table 3.

In the adjusted model, infant characteristics associated with substantiated or probable AHT (n = 265) included presence of a birth defect, male sex, and preterm birth. The odds of substantiated or probable AHT nearly doubled in families with young maternal age (<21 years). Infants born to military mothers were more likely to be a substantiated or probable case of AHT. Compared with military families with a nonmilitary mother, infants born to military mothers with a nonmilitary spouse had a 3.6 greater odds, those born to single military mothers had a 3.1 times greater odds, and those born to dual military families had a 2.5 greater odds of being cases. Factors that appeared to be protective were having a military parent who was a National Guard/Reserve member and higher sponsor rank (Table 4).

Cumulative categories for substantiated, probable, and possible AHT were used to determine the rates of AHT by year (Fig 1). AHT rates increased in 2001 (Fig 1), but the increase was only significant for substantiated AHT cases (P = .002). The cumulative estimated rates for AHT per 100 000 Registry infants were as follows: 34.0 (95% CI: 29.6–38.4) for substantiated cases, 39.2 (95% CI: 34.4–43.9) including probable cases, and 44.8 (95% CI: 39.7–49.8) including possible cases (Fig 2). Applying Ellingson et al's[18] definitions decreased calculated rates to 25.6 (95% CI: 21.8–29.4), which is similar to rates found in the civilian population as shown in Fig 2.

There were 147 AHT case infants born after September 11, 2001. Of these, 128 were considered unexposed to

TABLE 3 Infant, Maternal, and Military Sponsor Demographic Characteristics of Substantiated, Probable, and Possible AHT Cases Among DoD Birth and Infant Health Registry Infants Born 1998–2005

	AHT Case Category						Total Registry Infants	
	Substantiated		Probable		Possible			
	n	%	*n*	%	*n*	%	*n*	%
Total	230	100.0	35	100.0	38	100.0	676 827	100.0
Any birth defect								
No	205	89.1	30	85.7	35	92.1	653 444	96.5
Yes	25	10.9	5	14.3	3	7.9	23 383	3.5
Infant sex								
Female	89	38.7	12	34.3	15	39.5	329 323	48.7
Male	141	61.3	23	65.7	23	60.5	347 504	51.3
Infant birth status								
Full term	187	81.3	32	91.4	33	86.8	627 716	92.7
Preterm	43	18.7	3	8.6	5	13.2	49 111	7.3
Maternal age								
≥21 years	150	65.2	23	65.7	28	73.7	589 906	87.2
<21 years	80	34.8	12	34.3	10	26.3	86 921	12.8
Maternal military/marital status								
Dependent spouse	130	56.5	14	40.0	22	57.9	557 983	82.4
Military, single	46	20.0	7	20.0	7	18.4	39 546	5.8
Military, married	31	13.5	8	22.9	6	15.8	39 502	5.8
Dual military married	23	10.0	6	17.1	3	7.9	39 796	5.9
Sponsor age								
≥21 years	183	79.6	24	68.6	27	71.1	626 217	92.5
<21 years	47	20.4	11	31.4	11	28.9	50 610	7.5
Sponsor service branch[a]								
Army	87	37.8	8	22.9	15	39.5	250 263	37.0
Navy, Coast Guard	63	27.4	18	51.4	14	36.8	178 820	26.4
Air Force	57	24.8	3	8.6	3	7.9	169 792	25.1
Marine Corps	23	10.0	6	17.1	6	15.8	77 952	11.5
Sponsor rank[a,b]								
E01–E03	110	47.8	18	51.4	16	42.1	119 041	17.6
E04–E05	103	44.8	15	42.9	16	42.1	323 111	47.7
E06–E09	11	4.8	1	2.9	3	7.9	110 587	16.3
Officer	6	2.6	1	2.9	3	7.9	124 015	18.3
Unspecified enlisted	0	0.0	0	0.0	0	0.0	73	0.0
Sponsor race/ethnicity[a]								
White	136	59.1	20	57.1	25	65.8	446 104	65.9
Other/unknown	94	40.9	15	42.9	13	34.2	230 723	34.1
Sponsor educational level[a]								
No college degree	215	93.5	34	97.1	35	92.1	507 745	75.0
College degree	11	4.8	1	2.9	3	7.9	155 503	23.0
Unknown	4	1.7	0	0.0	0	0.0	13 579	2.0
Sponsor duty status[a]								
Regular duty	223	97.0	33	94.3	31	81.6	571 826	84.5
National Guard/Reserve	7	3.0	2	5.7	7	18.4	105 001	15.5

[a] The infant's sponsor is the military parent under whom the child is insured.

[b] Enlisted personnel are denoted as "E"; higher numbers indicate a higher pay grade.

deployment. Separate exact logistic regression models were performed for maternal and paternal deployment exposure because women are not deployed when known to be pregnant or immediately after delivery. In the paternal model, adjusted for maternal age and paternal rank, deployment was significantly different between the AHT and pneumonia groups ($P = .02$). "Sponsor on deployment" was significantly protective for the AHT group when compared with "not deployed" (OR: 0.36; 95% CI: 0.11–0.89). Because of the interaction of deployment timing and pregnancy/child birth, the maternal model was limited to comparing "not deployed" with "occurred while sponsor on deployment." In the maternal model, neither the univariable nor the adjusted models showed a significant effect.

DISCUSSION

This study assessed substantiated cases of AHT by linking electronic medical data indicating head trauma

TABLE 4 Adjusted ORs and Rates of Substantiated and Probable AHT Among DoD Birth and Infant Health Registry Infants Born 1998–2005

Characteristic	Total number of Infants	Number of AHT Cases	Cases per 100 000	Adjusted[a] OR of Substantiated and Probable AHT (95% CI)
Total	676 754	265	39.16	
Any birth defect				
No	653 373	235	35.97	1.00 (Referent)
Yes	23 381	30	128.31	3.04 (2.07–4.48)
Infant sex				
Female	329 287	101	30.67	1.00 (Referent)
Male	347 467	164	47.20	1.50 (1.17–1.92)
Infant birth status				
Full term	627 652	219	34.89	1.00 (Referent)
Preterm	49 102	46	93.68	2.29 (1.66–3.16)
Maternal age				
≥21 years	589 844	173	29.33	1.00 (Referent)
<21 years	86 910	92	105.86	1.71 (1.28–2.28)
Maternal military/marital status				
Dependent spouse	557 920	144	25.81	1.00 (Referent)
Military, single	39 545	53	134.02	3.13 (2.24–4.36)
Military, married	39 493	39	98.75	3.62 (2.52–5.20)
Dual military married	39 796	29	72.87	2.48 (1.66–3.72)
Sponsor service branch[b]				
Army	250 237	95	37.96	1.00 (Referent)
Navy, Coast Guard	178 785	81	45.31	1.11 (0.82–1.49)
Air Force	169 781	60	35.34	0.91 (0.65–1.26)
Marine Corps	77 951	29	37.20	0.89 (0.59–1.36)
Sponsor rank[b,c]				
E01–E03	119 041	128	107.53	1.00 (Referent)
E04–E05	323 111	118	36.52	0.49 (0.37–0.65)
E06–E09	110 587	12	10.85	0.20 (0.11–0.37)
Officer	124 015	7	5.64	0.22 (0.08–0.63)
Sponsor race/ethnicity[b]				
White	446 056	156	34.97	1.00 (Referent)
Other/unknown	230 698	109	47.25	0.88 (0.69–1.14)
Sponsor educational level[b]				
No college degree	507 698	249	49.04	1.00 (Referent)
College degree	155 488	12	7.72	0.53 (0.24–1.14)
Unknown	13 568	4	29.48	0.90 (0.33–2.44)
Sponsor duty status[b]				
Regular duty	571 758	256	44.77	1.00 (Referent)
National Guard/Reserve	104 996	9	8.57	0.43 (0.21–0.87)

[a] Analyses adjusted for presence of a birth defect, infant sex, preterm birth, maternal age and military status, and sponsor service branch, rank, race/ethnicity, and educational level.

[b] The infant's sponsor is the military parent under whom the child is insured.

[c] Enlisted personnel are denoted as "E"; higher numbers indicate a higher pay grade.

to temporally matched investigative data indicating substantiated physical abuse. Based on these criteria, the estimated rate of substantiated AHT in the military population was 34.0 cases per 100 000 live births. Although our study definition may be more sensitive than those used in other database studies, successful matching to investigative data suggests that the approach used in our study was sound. Including both substantiated and probable cases increased the estimated rate of AHT in the military to 39.2 cases per 100 000 live births (95% CI: 34.4–43.9), above the confidence limits of the rate found in the civilian population in 2000 (27.5 per 100 000 infants per year; 95% CI: 22.6–32.3) but within the confidence limits for civilian rates in 2003 (32.2 per 100 000 infants per year; 95% CI: 26.9–37.4).[18] These increased rates are explained in part by the fact that the Registry is neither limited to pediatric ICU patients nor to hospitalized patients. Also, the Registry allowed us to follow individual infants longitudinally and to capture all cases that occurred while the infant was a military dependent up to 12 months of age.

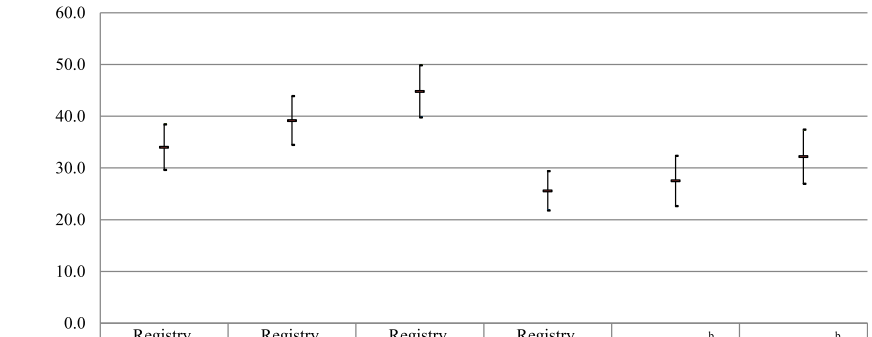
AHT rates in the military were similar to those found in the KID database when we used the same case-finding methods in our inpatient records that Ellingson used for KID. This suggests both that the military population is not at excess risk of AHT compared with civilian populations and that large data set studies in civilian populations may underestimate the scope of the problem.

Rates of substantiated AHT among military infants increased in 2001 (Fig 1). When examined by month (data not shown), the increase began in September 2001 and continued for several months. An increased AHT risk was previously associated with stressful events, such as a natural disaster.[22] Similarly, it is feasible that the events of September 11, or the strain of impending deployment, could have acted as stressors that resulted in the elevated number of cases. However, this link to potential stressors following the events of September 11 must be considered speculative because it is based on very small numbers.

Two previous studies in North Carolina suggested an excess risk of AHT in infants born to military sponsors.[11,12] Both studies had relatively small sample sizes and were performed in the same geographic region. This study did not find an elevated risk in military families, suggesting that although there may be a regionally elevated risk of AHT, this may not hold true for the military population as a whole.

FIGURE 1

Rates of abusive head trauma per 100 000 DoD Birth and Infant Health Registry infants, by case definition applied and birth year. [a]Application of the Ellingson et al[18] case definition criteria to Registry infants; [b]rates for the probable case definition include counts for substantiated and probable cases; [c]rates for the possible case definition are cumulative and include substantiated, probable, and possible cases.



	Registry, Substantiated	Registry, Probable	Registry, Possible	Registry, Ellingson[a]	KID 2000[b]	KID 2003[b]
- Lower CL	29.6	34.4	39.7	21.8	22.6	26.9
– Estimate	34.0	39.2	44.8	25.6	27.5	32.2
- Upper CL	38.4	43.9	49.8	29.4	32.3	37.4

FIGURE 2

Estimated rates of abusive head trauma per 100 000 DoD Birth and Infant Health Registry (Registry) infants, 1998–2005, compared with rates reported in other studies. [a]The rate that results when the Ellingson et al[18] definition is applied to DoD Birth and Infant Health Registry infants; [b]rates reported by Ellingson et al when applying their definition to the 2000 and 2003 KID databases, respectively. CL, confidence limit.

The use of the large and well-validated military data set allowed the exploration of risk factors for AHT with precision. Similar to previous studies, this analysis revealed that male infant sex was associated with substantiated AHT (adjusted OR: 1.5; 95% CI 1.17–1.92).[12,18,23] Unique to this data set was the ability to examine premature birth and birth defects, both of which were independently associated with AHT. This finding is important because these 2 groups of infants are more likely to be discharged from the NICU or the regular hospital ward. These higher AHT risk infants may not receive preventive education targeted at the newborn nursery.

Parental risk factors related to AHT included lower pay grade, young maternal age, and the presence of a military mother. Because neither care setting nor perpetrator information were fully available in this data set, further research is necessary to understand the elevated risk associated with military mothers and to develop meaningful programs to decrease this risk.

Finally, we examined deployment as an exposure on the basis of the hypothesis that AHT rates might be elevated during or after parental deployment, secondary to stress in the military parent deploying and then reintegrating into family life and stress to the parent who remained at home.[5] However, the majority of AHT cases did not occur in the setting of a recent deployment. In our exploratory analysis, the frequency of AHT cases was similar to the frequency of infant pneumonia cases with regard to deployment in all categories except for "sponsor on deployment" in the paternal model, which was protective. Within civilian populations, male caretakers are most frequently the perpetrators of AHT,[24,25] which could explain the protective nature of "sponsor on deployment." However, the lack of perpetrator information limits our ability to explain these differences. Caution should be applied when considering our deployment findings because only 77 AHT infants were included in the deployment analysis, with 5 of these in the "sponsor on deployment" category.

Limitations of this study include the use of large administrative data sets, which are open to misclassification due to coding errors; however, this type of error is less likely in our data sets because of the ability to follow infants longitudinally and to validate the codes used for specific infants. It

is possible that cases were missed if infants were born before the parent's enlistment in the military or if the case occurred after the parent left the military but before the child's first birth date. This situation may be a particular problem for Reserve/Guard individuals who may have been on active duty at the time of an infant's birth but deactivated at some point during the first year of life. Reassuringly, ~75% of infants in the Registry receive ≥9 months of care, thus any effect from this limitation is likely small. Finally, the data on deployment must be considered as preliminary due to small numbers and the risk of misclassification if members scheduled to deploy did not deploy.

Rates of AHT were similar to those in civilian populations when using the same case definitions. The rate of AHT was higher when applying the more sensitive study definitions, suggesting that civilian data sets relying on discharge coding alone may underestimate the incidence of AHT. Our data identified high-risk groups that warrant special attention. Families with parents in lower military pay grades, those with military mothers, and those with infants who are born premature or with birth defects may need additional support through the military's family support programs. Similarly, civilian parents of preterm infants or infants with birth defects might benefit from targeted prevention.

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14. ABSTRACT
Objective: Evaluate the rate of, and risk factors for, abusive head trauma (AHT) among infants born to military families and compare with civilian population rates.

METHODS: Electronic *International Classification of Diseases* data from the US Department of Defense (DoD) Birth and Infant Health Registry were used to identify infants born to military families from 1998 through 2005 (*N* = 676 827) who met the study definition for AHT. DoD Family Advocacy Program data were used to identify infants with substantiated reports of abuse. Rates within the military were com- pared with civilian population rates by applying an alternate AHT case definition used in a civilian study.

Results: Applying the study definition, the estimated rate of substantiated military AHT was 34.0 cases in the first year of life per 100 000 live births. Using the alternate case definition, the estimated AHT rate was 25.6 cases per 100 000 live births. Infant risk factors for AHT included male sex, premature birth, and a diagnosed major birth defect. Parental risk factors included young maternal age (<21 years), lower sponsor rank or pay grade, and current maternal military service.

Conclusions: This is the first large database study of AHT with the ability to link investigative results to cases. Overall rates of AHT were consistent with civilian populations when using the same case definition codes. Infants most at risk, warranting special attention from military family support programs, include infants with parents in lower military pay grades, infants with military mothers, and infants born premature or with birth defects.

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